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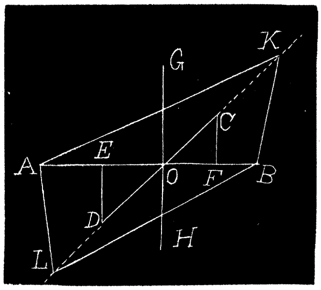
Let x=unknown diagonal, $\beta=\angle COB$, h=altitude of triangle above AB, h_1=the altitude of the triangle below AB, a=given diagonal.

$$x=2\triangle/a\sin\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Divide AB at O in ratio $m:n$ and draw the indefinite line KL making an angle β with AB.



Let $CO=p$, $DO=q$, $OK=y$, $OL=z$.

$$\therefore\ y=xp/(p+q)=2p\triangle/\{a(p+q)\sin\beta\},$$

$$z=xq/(p+q)=2q\triangle/\{a(p+q)\sin\beta\}.$$

$$\therefore\ h=2p\triangle/\{a(p+q)\}$$

$$h_1=2q\triangle/\{a(p+q)\}.$$

Draw OG, OH perpendicular to AB and $=h$, h_1; draw GK, LH parallel to AB, cutting KL in K and L. $\therefore$ $AKBL$ is the quadrilateral.

III. **Solution by A. H. BELL, Hillsboro, Ill., and F. R. HONEY, Ph. B., New Haven, Conn.**

Let a, and b, equal the segments of the given diagonals.

Let $x+y$, and $x-y$, equal the segments of the other diagonals.

Let r=the given ratio of the later diagonal, and θ the angle. Then

$$\frac{x+y}{x-y}=r \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Also, $ax\sin\theta+bx\sin\theta=c$ the given area$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$(2).

$$(2)\text{ and }(1)\ x=\frac{c}{(a+b)\sin\theta}=\frac{r+1}{r-1}y\ldots\ldots\ldots\ldots (3).$$

$$y=\frac{c(r-1)}{(a+b)(r+1)\sin\theta},\quad x+y=\frac{2cr}{(a+b)(r+1)\sin\theta},\quad x-y=\frac{2c}{(a+b)(r+1)\sin\theta}.$$

Now having all the segments of the two diagonals with the given angle between them, the construction of the required quadrilateral is very simple.

MECHANICS.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

52. **Proposed by S. ELMER SLOCUM, Union College, Schenectady, New York.**

A chain 16 feet long is hung over a smooth pin with one end 2 feet higher than the other end and then let go. Show that the chain will run off the pin in about 7-5 second. [*Wright's Mechanics*, page 92.]

I. **Solution by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.**

Let 16 feet$=2a$, 9 feet$=b$, and $x=$the length of the longer part of chain at any time t from the beginning of motion. Then, if m be the mass of a unit of length of the chain, $g=32$, the equation of motion is

$$\frac{d}{dt}\left(2ma\frac{dx}{dt}\right)=2mg(x-a)\ \ldots\ldots\ldots\ldots\ldots\ldots(1).$$

Multiplying both members by $\dfrac{d(x-a)}{dt}$ and integrating,

$$a\left(\frac{d(x-a)}{dt}\right)^2=g(x-a)^2+C\ \ldots\ldots\ldots\ldots\ldots\ldots(2).$$

When $x=b$, $\dfrac{d(x-a)}{dt}=0$, and $C=-g(b-a)^2$;

$$\therefore\ (2)\text{ is } a\frac{d(x-a)}{dt}=g\sqrt{(x-a)^2-(b-a)^2}\ \ldots\ldots\ldots\ldots\ldots\ldots(3),$$

$$\text{or } dt=\sqrt{\frac{a}{g}}\,\frac{d(x-a)}{\sqrt{(x-a)^2-(b-a)^2}}\ \ldots\ldots\ldots\ldots\ldots\ldots(4).$$

$$\text{Integrating, } t=\sqrt{\frac{a}{g}}\log(x-a\left(+\sqrt{(x-a)^2-(b-a)^2}\right)+C'\ \ldots\ldots(5).$$

When $x=b$, $t=0$; $\therefore$ $C'=\sqrt{\dfrac{a}{g}}\log(b-a)$, and (5) then becomes

$$t=\sqrt{\frac{a}{g}}\log\left\{\frac{x-a+\sqrt{(x-a)^2-(b-a)^2}}{b-a}\right\}\ \ldots\ldots\ldots(6).$$

Introducing numbers, $t=1.38$ seconds.

II. **Solution by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University, Miss., and HENRY HEATON, M. Sc., Atlantic, Iowa.**

Let s denote the distance through which the lower end of the string descends in t seconds.

Then, since the acceleration equals the moving force divided by the mass moved,

$$\frac{d^2s}{dt^2}=\frac{2+2s}{16}g.$$

Integrating, $\left(\dfrac{ds}{dt}\right)^2=\frac{1}{8}g(s^2+2s)$, no constant being added since when

$s=0$, $\frac{ds}{dt}=0$. From the last equation $\frac{ds}{\sqrt{s^2+2s}}=\frac{\sqrt{2g}}{4}dt$ which, by integration, gives $\log_e(s+1+\sqrt{2s+s^2})=\frac{\sqrt{2g}}{4}t$, the constant again being zero, since when $t=0$, $s=0$, and $\log 1=0$.

Taking this between the limits 7 and 0, $t=\frac{7}{5}$, approximately.

Also solved by *G. B. M. ZERR*, *C. W. M. BLACK*, *J. SCHEFFER*, and the *PROPOSER*.

53. Proposed by J. C. NAGLE, M. A., C. E., Professor of Civil Engineering, Agricultural and Mechanical College of Texas.

Find the locus of the center of gravity of an arc of constant length for a parabola.

Solution by G. B. M. ZERR, A. M., Ph. D., President of Russell College, Lebanon, Va.

Let u, v be the coördinates of the center of gravity, $y^2=4ax$, be the equation to the parabola for any point on the curve.

$$\therefore\ su=\int_0^x xds=\tfrac{1}{4}(a+2x)\sqrt{ax+x^2}-\frac{a^2}{8}\log\left(\frac{a+2x+2\sqrt{ax+x^2}}{a}\right)$$

$$=\tfrac{1}{4}(a+2x)\sqrt{ax+x^2}-\frac{a^2}{4}\log\left(\frac{\sqrt{x}+\sqrt{a+x}}{\sqrt{a}}\right)$$

$$\frac{a^2}{4}\log\left(\frac{\sqrt{x}+\sqrt{a+x}}{\sqrt{a}}\right)=\frac{a}{4}(s-\sqrt{ax+x^2}).$$

$$\therefore\ su=\tfrac{1}{2}\sqrt{x}(a+x)^{\frac{3}{2}}-\tfrac{1}{4}as\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1).$$

$$sv=\int_0^x yds=\tfrac{4}{3}\sqrt{a}(a+x)^{\frac{3}{2}}-\tfrac{4}{3}a^2\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2).$$

a and x are both variable in (1) and (2). It does not appear easy to eliminate a and x and thus obtain an equation in u, v.

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DIOPHANTINE ANALYSIS.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

53. Proposed by A. H. BELL, Hillsboro, Illinois.

Given $x^2-114\frac{1}{4}y^2=\mp3$ to find the least values of x and y in integers.